Dress Rehearsal: 2023 El Niño Anticipatory Action Somalia, in the Shadow of 1997

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ABSTRACT

In 2023 Somalia saw the largest-ever scale of anticipatory action (AA) linked to a seasonal forecast. $24m was spent on preparedness and early response, based on forecasted flooding driven by El Niño and a positive Indian Ocean Dipole. 188 flood-related deaths occurred; 90% fewer than 1997, the last time similar climatic conditions were seen. Here we reflect on the role AA played in reducing mortality. While we document significant progress in forecasting, early warning and early action, we also note that exposure to extreme rainfall was substantially lower than in 1997 - and thus cannot confidently attribute the lower mortality to AA. Thus whilst 2023 was an AA milestone to be celebrated, it is a dress rehearsal for the threat posed by 1997-level rainfall, an event made more likely with climate change. With a strong El Niño forecast in 2026, building on 2023 is critical; we make recommendations here.

KEYWORDS
Anticipatory action | Somalia | Seasonal forecasting | El Niño | Flood early warning | Humanitarian response | Climate extremes | Disaster risk reduction

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1 | INTRODUCTION

Somalia is prone to flooding and high vulnerabilities exacerbate disaster risk. With climate change expected to increase the frequency of extreme flood seasons (Cai et al. 2014, MacLeod et al. 2024), reducing exposure and vulnerability to flooding is critical. Anticipatory Aciton (AA) is a critical tool in reducing this risk, as early warning and rapid release of funding allows communities to protect themselves. This importance is reflected in the UN aim of every person on earth protected by early warning systems by 2027 (WMO 2022) along with the prominence of AA in the UNFCCC Paris agreement (United Nations Framework Convention on Climate Change 2015).

AA relies on the ability to forecast hazard with sufficient time to act in advance. This condition is strongly met for Somalia due to association between seasonal rainfall, El Niño–Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD). In particular extreme rainfall totals during the "Deyr" season (approximately October to December) are much more likely during strong El Niño and positive IOD (pIOD) events (Ogallo et al. 1988, Black et al. 2003, MacLeod et al. 2021). Somalia also benefits from support of a strong regional climate centre, ICPAC (IGAD Climate Prediction and Application Centre), filling gaps in capacity whilst efforts continue to rebuild national meteorological forecasting capacity MoEWR (2021).

In mid-2023, both a strong El Niño and pIOD were forecast. The ICPAC seasonal forecast in August indicated high confidence in a wet season; an unprecedented level of certainty in seasonal rainfall forecasts. The humanitarian community widely publicized the El Niño event and significant efforts were undertaken to prepare for and mitigate flooding; records show funding totalling $24m for early action for the season in Somalia, across at least 15 organisations (Anticipation Hub 2024). The strong seasonal forecast signal was correct and with heavy rain and flooding occured - described as "once in a century" (UN CERF 2023a).

The last time a similar conjunction of El Niño and pIOD was seen - 1997 - the death toll in Somalia was 2311 (Delforge et al. 2025). In contrast 2023 saw the largest ever AA for a single event, initiated with the seasonal forecast outlook,[†] with mortality of 188, 90% fewer than 1997 (Federal Government of Somalia 2024).

Was AA the reason why 2023 mortality in Somalia was much lower than in 1997? A reasonable question, given the unprecedented $24m spent on flood preparedness and early response (Anticipation Hub 2024) contrasted with the first response in 1997 occurring only after mortality had already sharply risen. However, without a consideration of the relative difference in hazard exposure and vulnerability, attribution is premature.

Here we examine the role of 2023 AA in avoiding a repeat of 1997. We begin by describing the evolution of forecasting capacity and AA between 1997 and 2023. We then put the climate conditions of the two seasons in historical context, contrasting the magnitude of hazard and population exposure, before documenting interventions and impacts across the two seasons. Finally we discuss the intersection of these factors with strong vulnerability differences, draw conclusions on the likelihood that AA was the key factor in reducing harm and make recommendations for AA development in Somalia.

[†] Analysis of Activation Hub data on all activations globally since records began (2022, not shown) shows most funding for 2023 flooding Somalia ($24m) followed by 2023 drought Somalia ($18m) and then South Sudan drought ($16m). In addition, many more institutions were involved in AA for this event compared to other events: Activation Hub data lists 15, although the true number is higher than this, since several organisations for which AA involvement is described in this paper are missing from the Hub data.

2 | METHODS

We use a range of sources to tell the story of the 2023 early action in Somalia and contrast with experiences in 1997. Contemporaneous reporting and academic literature support a narrative of improvements in forecasting, early warning and anticipatory action along with events and impacts in the two seasons. Information on activations in 2023 also derives from experience of co-authors.

Analysis of ENSO and IOD strength is based on monthly indicies of Niño 3.4 and Dipole Mode Index (Trenberth 1997, Saji and Yamagata 2003) published by NOAA, derived from HadISST1.1 (Rayner et al. 2003). Rainfall analysis is based on two independent estimates, accounting for dataset uncertainty: version 3 of CHIRPS (Climate Hazards InfraRed Precipitation with Stations, Funk et al. (2015) and TAMSAT (Tropical Applications of Meteorology using SATellite and ground-based observations (Maidment et al. 2014). Climate index and rainfall data are averaged across October-December (OND) except for analysis in Figure 4, which presents pentad and daily rainfall accumulation across the season for CHIRPS and TAMSAT respectively.

Forecasts for 2023 originate from the Copernicus Climate Data Store and the technical statement from the 65th GHACOF, produced by IGAD Climate Prediction and Application Centre (ICPAC) (ICPAC 2023). ENSO forecasts from 1997 are adapted from Anderson and Davey (1998), and experimental rainfall forecasts for 1997 are colourized from Graham et al. (1997).

VIIRS satellite data is used to map the spatial extent of inundation in 2023 (Li et al 2018). VIIRS has 375m resolution, the maximum of a daily-updated five-day composite taken to assess flooding, where any pixel with water above 20% is considered to be inundated. Although Landsat imagery is available for 1997 and was examined, a combination of methodological differences, scene availability and significant cloud cover resulted in a strong underestimation of inundation relative to ground reporting. The scale of the underestimation rules out meaningful comparison and so is excluded.

Population exposure analysis is based on population estimates from WorldPop, specifically the 100m resolution unconstrained estimates (WorldPop 2018). Gridded estimates are available between 2000 and 2020, and pointwise linear regression was used to produced estimates for 1997 and 2023 (results are insensitive to use of extrapolated values of 1997 and 2023 or extant data points at 2000 and 2020).

Total event mortality for all years is based on EM-DAT records (Delforge et al. 2025), although the entry for 2023 (122) is less than reporting by the Somalia Government records (188); we take the latter as authoritative (Federal Government of Somalia 2024). Daily mortality for 1997 was collated from daily humanitarian reports from the Somalia Aid Coordination Body (SACB), with weekly estimates for 2023 from Office for Coordination of Humanitarian Affairs (OCHA) reports (both available on Reliefweb, e.g. SACB (1997a), OCHA (2023a)). These in-season reports are also used to document the evolving impacts and response across the two seasons.

3 | RESULTS

3.1 | Improvements in seasonal forecasting and early warning

Empirical methods linking weather-station statistics to seasonal outcomes emerged over 100 years ago (Walker and Bliss 1930), becoming more powerful as the global observation network expanded (Namias 1964).[‡] The importance of slowly varying ocean-temperature patterns was recognised in the 1970s as El Niño's role in global climate variability became clear (Davis 1976, Troccoli 2010). Despite experimental ENSO forecasts existing in the 1970s there were no early warnings for the 1982 El Niño (Quinn 1974). This prompted development of the Pacific TAO monitoring array, leading to significant improvements in ENSO forecasting (Cane et al. 1986). For the first time in 1997, the rapid onset of El Niño was seen in advance (McPhaden 1999).

3.1.1 | Early warning 1997

In 1997, ENSO forecasts up to 12 months ahead were routinely issued by NOAA's Climate Prediction Centre (CPC) (Anderson and Davey 1998), appearing in the monthly Climate Diagnostics Bulletin (CDB), produced since 1983 (CDB archive since 1999 available at www.cpc.ncep.noaa.gov/products/CDB/CDB_Archive_html/CDB_archive.shtml; earlier issues at https://ci.nii.ac.jp/ncid/AA11610304). However, despite the ambitious forecast horizon, late 1996 forecasts did not anticipate El Niño development in 1997 (Anderson and Davey 1998), although later updates showed emerging signals.

By late 1996 coupled atmosphere–ocean seasonal-forecast systems were running ensembles to 6 months ahead (Stockdale et al. 1998). Forecasts initialised in November 1996 (Figure 1a) clearly showed El Niño developing as 1997 began, with the forecast from August 1997 (Figure 1b) showing continued strengthening as the event reached extreme magnitude. A first real-time regional rainfall forecast for October–December 1997 was issued in September (Graham et al. (1997), Figure 1c). The forecast system comprised an atmosphere-only ensemble forced with persisted August ocean temperatures, with hindcasts suggesting potential skill over East Africa. For northern East Africa (region A in Figure 1c), all nine ensemble members predicted above-average rainfall, and the ensemble mean exceeded all anomalies in the 15-year hindcast. One month later the International Research Institute for Climate and Society (IRI) issued its first public forecast, giving a 60% chance of above-normal rainfall across most of South-Central Somalia (Supplementary Figure 1).

In Africa there was already capacity for issuing seasonal forecasts in 1997. WMO Drought Monitoring Centres (DMCs) had been established in 1989 in Nairobi and Harare, and by 1997 they were providing 24 countries with climate advisories, including warnings of droughts, floods and other extremes (Ambenje, PG 2000), with the Nairobi DMC (now ICPAC) issuing seasonal forecasts since 1991 (Basher et al. 2001, Curry 2001).

Although no archive survives, it is likely that DMC advisories warned of a wet 1997 OND: the El Niño–OND rainfall link was well established (Ogallo et al. 1988), with the UK Met Office likely sharing its experimental forecast (Mike Harrison, personal communication) and connections

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[‡] Traditional methods of anticipating seasonal changes likely long predate these methods, where bio-physical indicators are used to anticipate seasonal shifts (Acharya 2011, Okonya and Kroschel 2013, Balehegn et al. 2019).

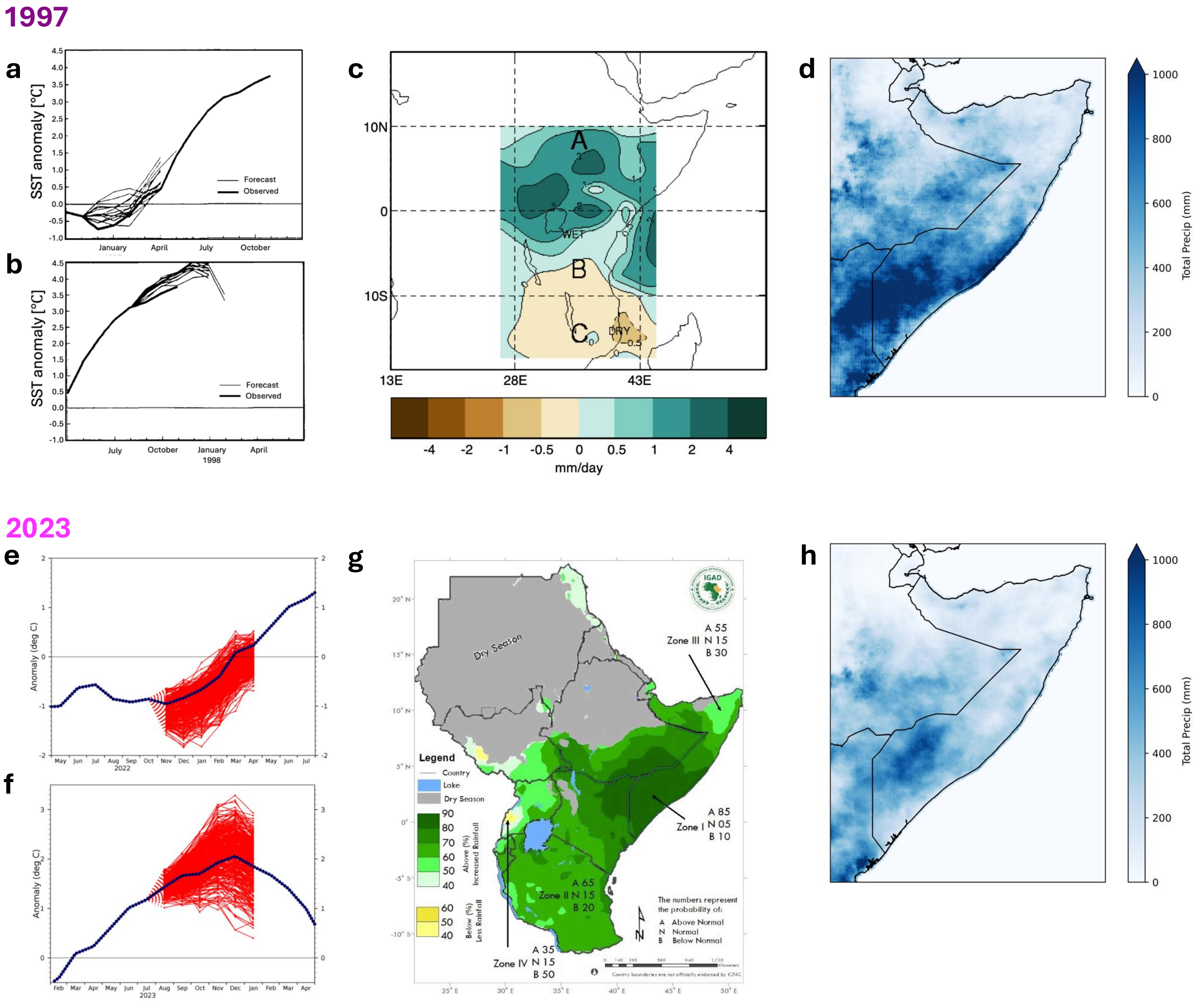

FIGURE 1 El Niño and a wet OND in East Africa were well predicted in both 1997 and 2023 (a, b) forecasts of Niño 3.4 issued in November 1996 and May 1997 from ECMWF (adapted from (Anderson and Davey 1998) (c) experimental ensemble mean forecast of OND rainfall anomaly issued September 1997 (adapted from Graham et al. (1997)) and (d) observations of OND rainfall anomalies from CHIRPS. (e-h) as (a-d) but for 2023, where (e,f) are Niño 3.4 forecasts from the Copernicus multi-model ensemble and (g) is the objective GHACOF seasonal rainfall forecast (showing the predicted probability of the most likely tercile category), issued August 2023.

between DMC and IRI (Basher et al. 2001). Nationally, whilst Kenya's Meteorological Department reportedly forecast heavy El Niño-related rainfall as early as July 1997 (Karanja et al. 2000), Somalia lacked a national early-warning system. Once among the region's strongest meteorological services, Somalia's system collapsed after 1990 as civil war intensified, leaving most equipment non-functional or destroyed (MoEWR 2021).

Dissemination of bulletins from DMC Nairobi by 1997 was via postal mail, email, its website, and on request (Curry 2001). Problems noted at the time included delayed emails, stalled information at higher institutional levels and overall low trust in seasonal forecasts. The Kenya Meteorological Department's El Niño warning, for example, was "received with skepticism due to alleged earlier 'wrong' forecasts" (Karanja et al. 2000). Thus although warnings of potential flooding were available, they were not given substantial weight. This is corroborated by an inter-agency report following the 1997 flooding (Bradbury and Coultan 1998):

> ”The severity and extent of the rainfall that fell over East Africa was not forecast, either by local national meteorological services, or by international climate prediction centres. [...] FEWS staff, who are disciplined in reviewing a wide range of sources of climate prediction information, and had just attended a conference of international experts on El Niño, ‘were not expecting’ floods of such severity. [...] FEWS accessed the International Research Institute web-site on or around 13 October 1997, to view the Experimental Climate Forecast Division 90-day Rainfall Forecast for Africa for October–November–December.[§] The document was immediately passed on to FSAU, USMD and possibly FAO. The forecast indicates for much of the Horn [...] a 60% probability of above-normal rainfall. While this represents the highest given probability for any region over the whole of Africa for the forecast period, no special alerts were said to accompany the map, and a 60% probability did not appear to be sufficiently conclusive to warrant issuance of a severe weather warning or flooding alert.”

3.1.2 | Developments 1997–2023

After 1997, understanding of the drivers and predictability of East African rainfall expanded well beyond its association with ENSO (Ogallo et al. 1988). The IOD was first identified in 1999 (Saji et al 1999), with association between pIOD and exceptionally strong OND rains over the region soon noted (Black et al. 2003, Goddard and Graham 1999). Later analysis revealed that although El Niño and pIOD events often co-occur, the IOD is only partly dependent on ENSO (Ashok et al. 2003), with the ENSO-dependent IOD variability predictable at long lead, and the ENSO-independent part much less so (Stuecker et al. 2017).

The dominant role of pIOD in shaping OND rainfall over East Africa has become increasingly clear. In 2015, a “Godzilla” El Niño—forecast to exceed the magnitude of 1997 (Schiermeier 2015, Santoso et al. 2017) prompted strong expectations of extreme flooding in East Africa and early action (Tozier de la Poterie et al. 2018). Yet widespread impacts did not occur; heavy rainfall remained localized (Siderius et al. 2018) because the Indian Ocean failed to exhibit the expected pIOD (MacLeod and Caminade 2019).

Subsequent analyses of direct and indirect causal pathways between ENSO, IOD and OND rainfall helped explained the unexpectedly moderate 2015 rainfall (MacLeod et al. 2021). Although ENSO is correlated with OND rainfall, its influence is strongly determined by the IOD: specifically, El Niño is much more likely to produce a strong wet season if it triggers a pIOD. However pIOD alone is sufficient for flooding, as demonstrated by the exceptionally wet 2019 short rains, driven by pIOD occurring independently from any El Niño (Wainwright et al. 2021).

Along with scientific understanding, dissemination of seasonal forecasts also expanded after 1997. In July 2000, CPC began issuing monthly ENSO Diagnostic Discussions, summarising atmospheric conditions and tropical Pacific ocean temperature forecasts. An alert system was introduced in 2009 (Kousky and Higgins 2007), issuing a “Watch” when conditions favour El Niño/La Niña development within three months and an “Advisory” when they are observed and expected to continue. ENSO strength categories (“weak,” “moderate,” “strong”) were also standardised for

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[§] Supplementary Figure 1

Niño 3.4 anomalies above 0.5, 1.0, and 1.5°C. Around the same time, IOD status began appearing in seasonal outlooks, notably in the Bureau of Meteorology's (BoM) "ENSO Wrap-Up," which first included IOD forecasts in 2008 (http://www.bom.gov.au/climate/enso/archive/ensowrap_20080604.pdf). Model evaluation showed skill for predicting IOD behaviour at peak time at leads up to four months, with rapid loss of skill for forecasts initialised before June (Zhao and Hendon 2009).

The 1997 El Niño gave momentum to the new RCOF platform (Basher et al. 2001), with the inaugural Greater Horn of Africa Climate Outlook Forum (GHACOF) in 1998. Hosted by DMC Nairobi with WMO support, GHACOF consolidated forecast information and expert review. Its primary output was the consensus forecast — an expert, subjective assessment of seasonal rainfall likelihoods — whilst also providing a platform for engagement between meteorologists, researchers, and users.

GHACOF grew in strength and prominence. In 2003, DMC Nairobi became a specialised IGAD institution, before evolving into ICPAC in 2007. ICPAC was designated a WMO Regional Climate Centre (RCC) in 2017, and in 2019 adopted an objective forecast-generation approach with statistical calibration of model inputs (Hansen et al. 2022). This happened against a background step-change in global support for seasonal forecasting for ICPAC and other RCCs, evolving from a few global centres with emergent operational systems in 1997 to a network of WMO-designated operational centres established in 2006 (Graham et al. 2011) with support later extending to sub-seasonal as well as annual-to-decadal timescales (Kumar et al. 2024).

For Somalia important progress in re-establishing monitoring and forecasting capacity occurred after 1997. The hydrometeorological network was rebuilt through FAO-SWALIM, which repaired and installed weather stations and established river-gauging sites. The Ministry of Energy and Water Resources (MoEWR) and FAO-SWALIM, with UNDP support, developed Digniin since 2015, an SMS alert system alerting on flood risk. However by 2023, it remained the case that no single national institution effectively provided climate early warnings (MoEWR 2021). The hydrometeorological department of MoEWR is responsible for managing hydrometeorological activities and monitoring at the federal level whilst different ministries hold mandates for early warning in different regions with EWS responsibilities divided. Yet, limited capacity prevents systematic warning production or dissemination with assessment indicating an absence of trained meteorologists in ministries and chronic constraints in computing, forecasting and communication within MoEWR (MoEWR 2021).

3.1.3 | Early warning 2023

Early 2023 marked the end of a multi-year La Niña associated with prolonged regional drought (Odongo et al. 2024). With La Niña officially ending in March, an El Niño Watch followed in April (CPC 2023ab). By June, CPC issued its first El Niño Advisory, noting a weak event and a 54% probability of a strong event by OND (CPC 2023c). Later updates suggested it could rival 1997 or 2015 (CPC 2023d).

By August, the probability of a strong OND El Niño had risen to 66% (CPC 2023e). The IOD remained neutral, but in mid-August BoM outlooks indicated model consensus on an emerging pIOD (BoM 2023). Median forecasts suggested the pIOD magnitude might exceed 1997 (it ended up slightly weaker than 1997) and in the event, 2023 became only the second OND since 1981 with both a strong El Niño and a pIOD (Figure 2).

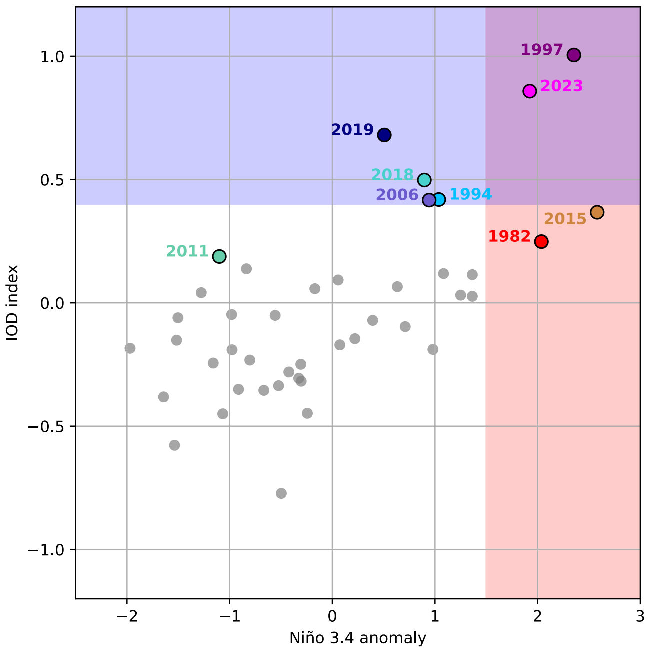

FIGURE 2 Significant El Niño and pIOD events since 1981. Red, blue and purple areas indicate thresholds of strong El Niño, pIOD or both as defined by NOAA and BoM. Dot colours highlight years falling in these categories and are used in Figure 6 (2011 is included due to unusually high rainfall given the lack of either).

On 22 August 2023, ICPAC issued its OND forecast at the 65th GHACOF (ICPAC 2023). The outlook indicated a marked increase in wet-season likelihood across the region (Figure 1g), consistent with strong El Niño and pIOD signals and understanding of their combined influence. Southern Somalia showed the highest probabilities, with the chance of a one in three year wet season (upper tercile) exceeding 85% — the strongest signal in 25 years of GHACOF forecasts.

By contrast to the experimental 1997 forecasts, anticipation of the 2023 El Niño was widely publicised across multiple channels. ICPAC's dissemination was supported by structured engagement with media and users at GHACOF and post-GHACOF events. In recent years GHACOFs draw 250 in-person and 100 virtual participants, and forecasts are shared via a mailing list of 12,000 subscribers and social media accounts (24,700 followers on X; 132,000 on Facebook), with ICPAC also promoting consistent messaging through a seasonal "Media Action Plan" for journalists (ICPAC, personal communication).

Along with wider dissemination, 2023 also saw humanitarian actors who were more familiar with seasonal forecasting and the use of forecasts in general. By early 2023, at least 70 AA frameworks were active globally, covering 7.6 million people with US$138 million in committed financing (Anticipation Hub 2024). The result: widespread dissemination of outlooks for Deyr 2023 prompted government and humanitarian agencies to begin preparedness measures in Somalia. The development of anticipatory action culminating in this effort is described in the next section.

3.2 | Increases in capacity and willingness to act early

Short-term weather forecasts have long informed planning and disaster management. As seasonal forecasts expanded, so did the potential for humanitarian anticipatory action, enabling earlier interventions. However, there is little evidence of significant humanitarian action based on the 1997 El Niño forecasts (Tall et al. 2012). At the time, humanitarian responses to natural disasters in East and Southern Africa were:

> "...predominantly related to slow-onset drought events ... [with] early warning systems developed to be sensitive at recognising light or failed rains at critical points in the agricultural calendar. Only in areas such as Madagascar, where cyclones are a recurrent threat, [were] well developed early warning and rehearsed response systems developed to contend with sudden onset disaster" (Bradbury and Coultan 1998).

After 1997, seasonal forecasts were increasingly integrated into decision-making, with mixed results (Patt et al. 2007). In Ethiopia, humanitarians considered drought forecasts but hesitated to commit resources due to forecast uncertainty (Broad and Agrawala 2000). In Mozambique, wet-season forecasts led the government to hold more disaster committee meetings, develop response plans, and conduct preparatory exercises, yet advance mobilisation remained limited and external assistance was delayed for months (Hellmuth et al. 2007).

A key milestone came in 2008 (Tall et al. 2012). Following severe 2007 flooding in West Africa, the International Federation of the Red Cross (IFRC) collaborated with climate centers ahead of the 2008 rainy season and when forecasts indicated above-normal rainfall they prepared for riverine flooding, securing funds to preposition relief items for up to 9,500 families and issuing intensified alerts. Post-event evaluations reported much faster response times, with relief reaching affected communities within days rather than weeks, reportedly reducing loss of life and improving resource efficiency (Braman et al. 2013).

The next major opportunity for El Niño-based early action came in 2015, when forecasts and advisories were widely disseminated ahead of the Deyr season (Tozier de la Poterie et al. 2018). Although information reached humanitarian organisations in good time, most actors relied on analogue years rather than seasonal rainfall forecasts or other drivers. In Somalia, agencies were instructed to examine the previous six El Niños to identify likely flood areas, prioritising actions with medium- or long-term benefits regardless of weather—reinforcing riverbanks, pre-positioning non-perishables, desilting rivers, and clearing drainage (Tozier de la Poterie et al. 2018). When flooding proved less severe than anticipated — partly due to the absence of a strong pIOD (see section 3.1.2) - humanitarians were unprepared when an unexpected drought occurred "in a totally different location that was not part of the plan" (Tozier de la Poterie et al. 2018).

3.2.1 | Global policy and protocol

Global policy on AA has evolved significantly between 1997 and 2023. The Framework for Action 2005–2015 outlined five priorities, including improving early warning systems, though it did not specify mechanisms for translating warnings into action (ISDR 2005). Its successor, the Sendai Framework 2015–30, introduced a target to "substantially increase the availability of and access to multi-hazard early warning systems by 2023" (UNDRR 2015). The IPCC Paris Agreement further prioritized preparedness for climate hazards (United Nations Framework Convention on Climate

Change 2015). Building on these initiatives, the Early Warnings for All Initiative was launched in 2022, aiming to ensure universal coverage by hydro-climatic early warning systems by 2027 (WMO 2022).

Alongside global policy progress, humanitarian organisations have developed systematic operational approaches to anticipatory action. Since the IFRC's experience in West Africa, anticipatory action within the Red Cross Red Crescent Movement evolved into "Forecast-based Financing" (Coughlan de Perez et al. 2015), now formalised through Early Action Protocols (EAPs). Each EAP, validated by the IFRC, sets specific forecast-based triggers linked to pre-agreed actions; when triggers are met, the Disaster Risk Emergency Fund (DREF) releases funds for rapid implementation. There are now over 50 active EAPs, mostly for short-range flood and cyclone hazards, with some based on seasonal forecasts, including an EAP for drought in Somalia (IFRC 2024b). In 2023, eight EAPs were triggered, disbursing $10 million for anticipatory action (IFRC 2024a). Other organisations have also expanded anticipatory action: by 2023, the World Food Programme (WFP) reached over 4 million people in 36 countries (Programme 2024), and FAO supported more than two million people in 24 countries (FAO 2024).

3.2.2 | Early action in 2023

Through 2023 the humanitarian community was well aware of the evolving forecasts of first El Niño and by August, the high likelihood of extreme rainfall season in East Africa. Some agencies in Somalia already had AA plans for Somalia, while others began advance preparation for flooding in a more flexible way. We review this preparedness below, illustrating geographic coverage in Figure 3. NB This is not exhaustive, since at least 15 institutions undertook AA in Somalia in 2023 (Anticipation Hub 2024); not all are covered here though this review does represent the majority of the documented funding spent on anticipation.

WFP had $4.2m available for AA in Somalia and had been working with the Somali Disaster Management Agency (SoDMA) to develop an AA plan for flooding along the Juba and Shabelle. River height thresholds from FAO-SWALIM served as triggers, and ICPAC monitored daily forecasts from the GeoSpatial Streamflow Forecast Model (WFP 2024). On 5 October, after rapid water-level increases, SoDMA alerted stakeholders, recommending activation. On 10 October, trigger conditions were met, indicating riverine flooding in target districts within 10 days. Minimal preparedness had already begun, including community engagement and household registration. After activation, warning messages in local languages were disseminated via loudspeakers, radio, and a national mobile network to more than 400,000 people. Unconditional cash was transferred to over 200,000 vulnerable people, and food and boats were pre-positioned for rapid response (WFP 2024).

The Somalia Red Crescent Society (SRCS) did not have a validated flood EAP but upon the GHACOF forecast on 22 August applied for imminent DREF funding (funding action in advance of expected events without an approved EAP). Approved on 14 October, the plan requested 150,000 CHF to support 25,000 people in Puntland and Somaliland, to be triggered from weekly ICPAC extreme rainfall forecasts (IFRC 2023a). The trigger was met on 2 November (IFRC 2023b), enabling SRCS to disseminate warnings, promote WASH, distribute aqua tabs, sand bags, and shelter from the prepositioned stock to 5,400 people. SRCS also established evacuation centres, provided plastic bags for asset protection and relocated mobile clinics to areas at risk of flooding.

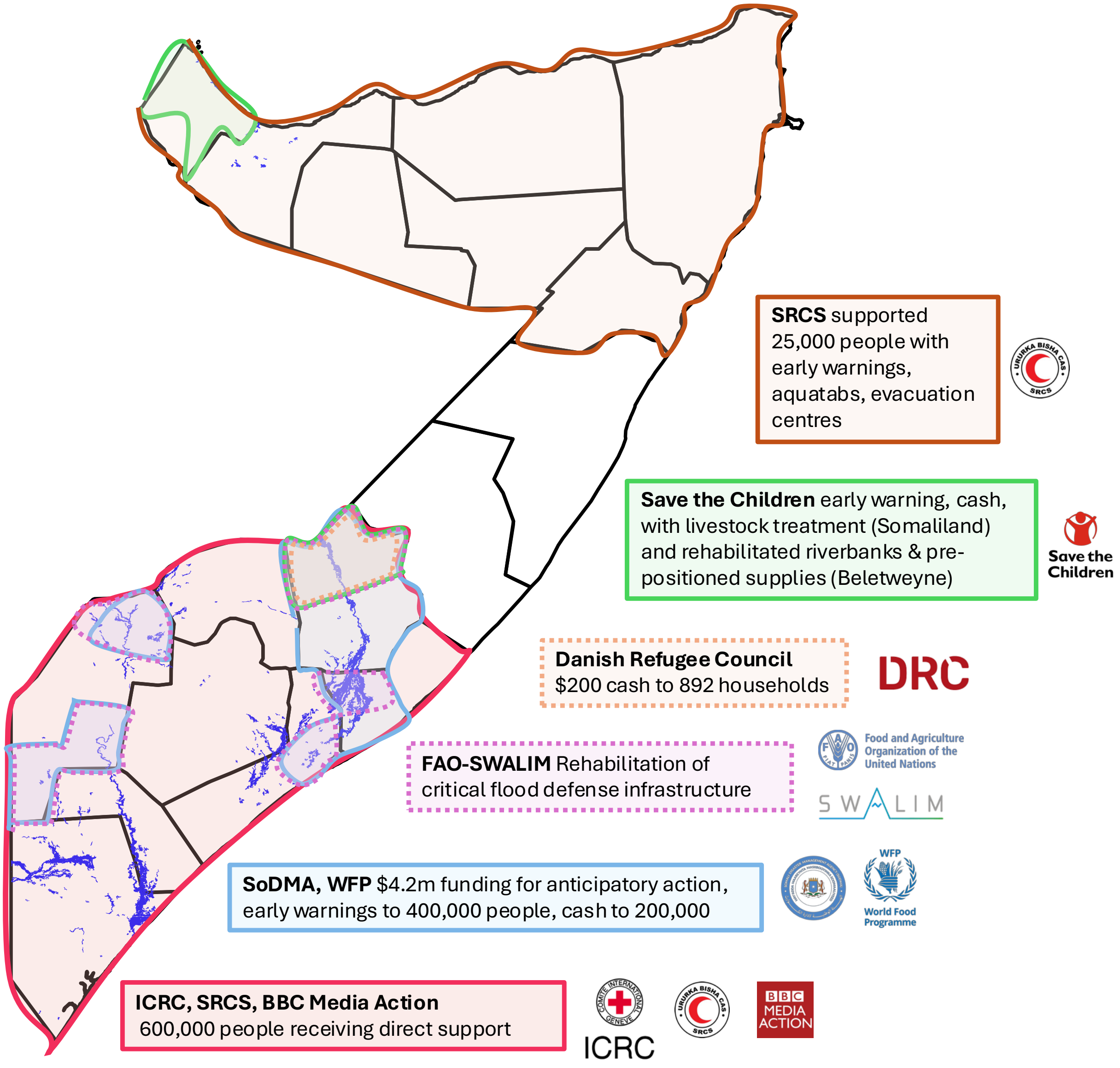

FIGURE 3 Locations in which AA was implemented during 2023. Dark blue solid fill shows the estimated inundation extent from VIIRS satellite data.

The International Committee of the Red Cross (ICRC) was also highly active. Working alongside SRCS, the ICRC supports communities in conflict-affected regions inaccessible to other agencies. No formal activation process existed, but after the Red Cross Red Crescent Climate Centre (RCRCCC) advised the Somali delegation of the serious nature of the forecast, ICRC halted ongoing activities from 21 August and pivoted to prepare for riverine flooding. No additional funding was provided; action was funded with flexible reorientation of existing budgets. Ultimately, 600,000 people received direct support from ICRC (ICRC 2024). Water points were protected, health centres reinforced, purification units distributed, and sandbags provided to safeguard livelihoods. Pre-positioned supplies enabled a rapid post-flood response. To navigate activity through the season ICRC rapidly consolidated shorter-range forecast sources into a bespoke tool co-designed with the RCRCCC, drawing on FAO-SWALIM monitoring, GloFAS, and Google's Flood Hub. These data were reviewed throughout the season in weekly meetings to guide tactical planning and update warnings. The RCRCCC supported through flood-risk mapping of vulnerable sites, including IDP camps and ICRC warehouses.

BBC Media Action also played a key role in regional preparedness. Supported by ICRC, they engaged with local journalists to help amplify and disseminate risk information across multiple channels, coordinating standard messaging with appropriate language and communication methods. This followed their "lifeline communication" approach: instead of a descriptive narrative of events, communicating actionable information for listeners. Efforts were triggered by the GHACOF seasonal forecast, then refined using shorter-range forecasts. Public service announcements covered eight topics, including "Caution on increased rains," "Handling acute water diarrhoea/cholera," and "Migration and Protection threats." Each three-minute message aired on BBC Somali Service three times weekly per language and on local partner stations three times daily, reaching an estimated 19 million people (BBC Media Action 2024).

Physical interventions were also carried out by FAO-SWALIM. In August $3.8m was available from the anticipatory action initiative "Badbaado" (a Somali word: 'to salvage from calamity'), with support from the British Embassy in Mogadishu. With this funding, FAO-SWALIM acted quickly to close river breakage points, rehabilitate major canals and preposition sandbags. In addition, they amplified early warnings and provided coordination to support evacuation planning.

Save the Children also implemented AA in Somalia and Somaliland, having explored approaches for over a decade. At the time of the first El Niño watch in April 2023 this involved an active AA project for flash flooding, funded by Community Jameel (Save the Children 2024). Following the seasonal outlook they worked to evaluate the possibility of using shorter-range forecasts to act before imminent flooding. Both the ICPAC next-week rainfall forecast as well as the ECMWF Extreme Forecast Index (EFI) with 4–8 day lead were considered. However it was determined that the ICPAC forecast provided insufficient lead time for actions under consideration, whilst analysis of archived EFI forecasts against historical observations deemed it to have insufficient skill to use as a trigger. Thus it was decided that precise triggering on shorter range forecasts was not possible; instead the August ICPAC seasonal forecast itself was used as a direct trigger: flooding was expected at some point in the season, even if the exact timing couldn't be anticipated well enough to guide actions.

This led Save the Children to disseminate mobile early warnings and provide cash transfers and livestock treatment for vulnerable households. With ECHO funding also undertook AA in Beletweyne, including community DRR information and trainings, refresher trainings for community health workers on disease outbreaks, pre-positioning of mosquito nets and medical supplies, school-based DRR activities to involve children, rehabilitation of riverbanks and multi-purpose cash support for vulnerable families. The Danish Refugee council were also active in Beletweyne, targeting 892 vulnerable households, with two unconditional cash transfers of $100 (DRC 2024). These were distributed on 8th November after warning of critical river levels on 4th November – four days before the river overflowed on 12th November and reportedly displacing 220,000 residents.

The International Rescue Committee (IRC), a relatively new AA actor, had been tracking forecasts and identified Somalia as a high-risk area. As the seasonal forecast signal became stronger, IRC secured internal funding as well as crisis modifier funds. These resources were used for awareness-raising, hygiene support, and unconditional cash transfers. Additionally, riverbanks were strengthened with sandbags, and mobile health units were deployed.

In addition $10m for rapid response was released from the UN CERF on 6 November as the government declared a state of emergency (UN CERF 2023b). Although this funding is included in the global stocktake of AA funding (Anticipation Hub 2024), it is arguably timely response, not AA. However the seasonal forecast was critical, as it triggered the advance preparation of the plan, allowing CERF to rapidly approve all projects.

In summary, diverse efforts prepared communities for flooding, initially triggered by the seasonal forecast. Some agencies focused on riverine flooding along the Juba-Shabelle rivers, others on flash floods in the north. WFP followed a pre-determined plan, SRCS accessed imminent DREF funding, and ICRC, Save the Children, and IRC applied flexible strategies. This unprecedented level of AA significantly improved awareness and capacity to respond when rains came and flooding impacts began to be felt. In the next section we contrast impacts across 1997 and 2023, comparing relative hazard magnitude and population exposure. Given lack of data explicitly quantify differences in vulnerability, we make a qualitative integration of this in the final section.

3.3 | Contrasting impacts and exposure

Figure 4 shows the quickly rising mortality and evolving challenges and impacts throughout November and December 1997. It was later reported that inside Somalia people were alerted to rising upstream river levels through their radio network and traders, with and many took avoidance measures (Bradbury and Coultan 1998). However by the time of the first available SACB report on 13 November 1997 (SACB 1997a), nearly 500 deaths had already been recorded. This figure rose quickly to over 1,000 by mid-November, following approximately 200mm of accumulated rainfall across the Juba-Shabelle basin, with an ”inland sea” forming at the confluence of the Juba and Shabelle rivers (Bradbury and Coultan 1998).¶ Rainfall accumulation continued to rise sharply, reaching around 500mm (averaged over the basin) by the end of November. Deaths continued to increase, reaching 1,500 by early December and eventually reaching 2,311 in 1998 as waterborne diseases such as cholera and bloody diarrhoea drove impacts on health.

A defining feature of the 1997 response in SACB reporting is the limited accessibility to affected communities. Delays in securing helicopters and boats meant many were marooned on rooftops or embankments at least a month after the flooding began. By the end of January, large areas were still severely affected, with roads impassable and communities cut off. The first humanitarian response was from emergency ICRC aid in early November, when mortality was already rising. The UN began airdropping food from planes from late November, although these efforts were hampered initially by packages breaking on impact - improving when helicopters became available in early December as the death toll reached 1,500.

Figure 4b shows the same timeline for 2023. Some localised flooding and a small number of deaths were reported as early as October, with access challenges noted by the end of that month due to impassable roads in the southern states, although the reported scale of access problems

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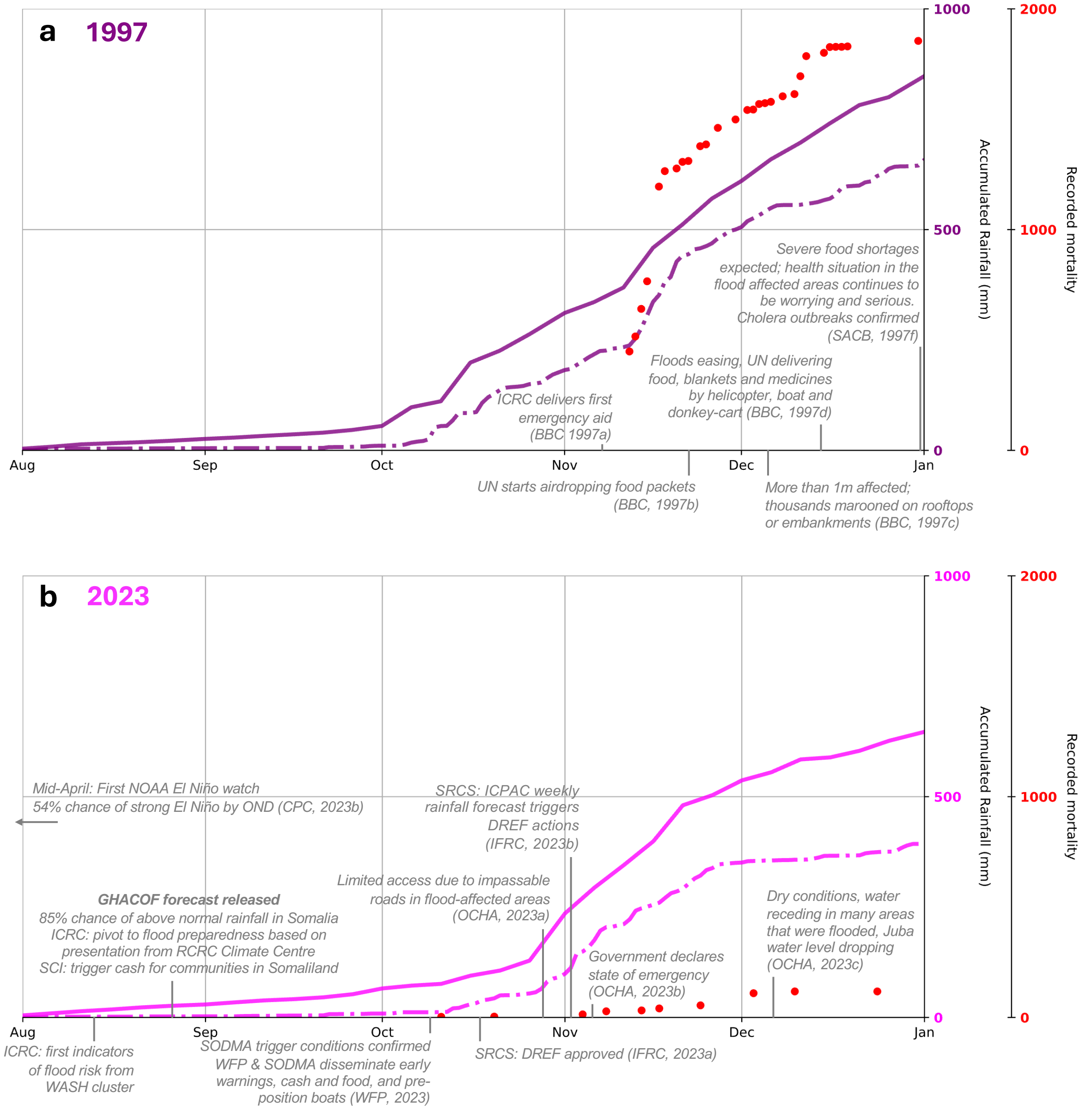
¶ The confluence of the Juba and Shabelle has historical been a large wetland, almost 200km long, known as the Baale wetland, or Shabelle terminal marshes. Anecdotal tales suggest it was flooded regularly in the past. Noting this, the reported formation of a huge ‘inland sea’ in 1997 suggests an echo of a historic biome.



Severe food shortages expected; health situation in the flood affected areas continues to be worrying and serious. Cholera outbreaks confirmed (SACB, 1997f)

Floods easing, UN delivering food, blankets and medicines by helicopter, boat and donkey-cart (BBC, 1997d)

ICRC delivers first emergency aid (BBC 1997a)

UN starts airdropping food packets (BBC, 1997b)

More than 1m affected; thousands marooned on rooftops or embankments (BBC, 1997c)

Mid-April: First NOAA El Niño watch
54% chance of strong El Niño by OND (CPC, 2023b)

SRCS: ICPAC weekly rainfall forecast triggers DREF actions (IFRC, 2023b)

Limited access due to impassable roads in flood-affected areas (OCHA, 2023a)

GHACOF forecast released
85% chance of above normal rainfall in Somalia
ICRC: pivot to flood preparedness based on presentation from RCRC Climate Centre
SCI: trigger cash for communities in Somaliland

Dry conditions, water receding in many areas that were flooded, Juba water level dropping (OCHA, 2023c)

Government declares state of emergency (OCHA, 2023b)

ICRC: first indicators of flood risk from WASH cluster

SODMA trigger conditions confirmed
WFP & SODMA disseminate early warnings, cash and food, and pre-position boats (WFP, 2023)

SRCS: DREF approved (IFRC, 2023a)

FIGURE 4 Comparative timeline of impacts in Somalia during 1997 and 2023. Estimates of daily rainfall accumulation in the Juba-Shabelle basin are shown as lines for CHIRPS and TAMSAT (solid/dashed). Mortality estimates are shown as red dots, extracted from in-season reporting by SACB daily reports for 1997 and OCHA weekly reports from 2023. Key moments of forecasts, anticipatory action, response and impact are annotated (where no citation is given, the source derives from direct co-author experiences).

was much lower than 1997. Rainfall then increased quickly throughout November and by mid-month, average rainfall over the Juba basin appeared to exceed 1997 levels at the same point in the season. However, rainfall accumulation slowed relative to 1997. This is reflected in reports from early December, noting that floodwaters were receding in many areas and that the Juba River was dropping (OCHA 2023c) unlike in 1997, when large areas were still flooded at the start the following January (SACB 1998). Compared to 1997 mortality remained low, eventually reaching 188 in 2024.

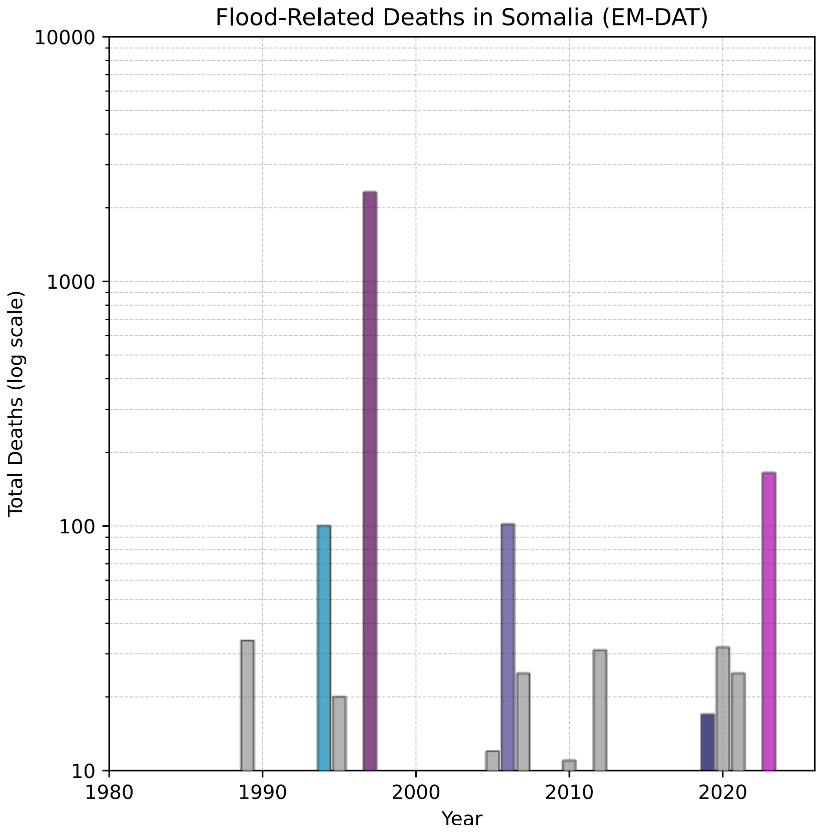


FIGURE 5 Recorded flood deaths in Somalia during October-December since 1981, EM-DAT (log axis).

Figure 5 places overall mortality the 2023 and 1997 events into historical context, using the EM-DAT database of flood-related deaths in Somalia since 1981. 1997 is an clear outlier, with 2023 a distant second. The third and fourth highest years were 1994 and 2006 with around 100 deaths each; both of these were pIOD years without an El Niño (Figure 2). By contrast, strong El Niño years without a pIOD, such as 1982 and 2015, show no recorded flood deaths in Somalia. This is consistent with scientific understand placing the IOD as the key factor in driving extreme Somalia rainfall (MacLeod et al. 2021).

To explore drivers of impacts, we first consider the spatial extent of high seasonal rainfall in Somalia across all years since 1981 (Figure 6). CHIRPS ranks 1997 and 2023 as the wettest and second-wettest, with markedly greater areas exposed to all rainfall thresholds in 1997: more than 200,000 km² received over 600mm in 1997 but less than 100,000km² did in 2023. At higher thresholds, the contrast grows: over 800mm was seen for 140,000 km² in 1997 but only 20,000 km² in 2023, and over 1,000mm affected 50,000 km² in 1997 but 0km² in 2023.

TAMSAT also ranks 1997 as the wettest year, but places 2019 second and 2023 third at lower thresholds. Surprisingly, 2011 surpasses 2023 at higher thresholds despite La Niña and IOD-neutral conditions (though IOD briefly neared the positive threshold within the season); indicating that near-threshold pIOD may still drive substantial rainfall. Despite dataset differences, 1997 remains a clear outlier in rainfall amount and extent. Supplementary analysis across the Juba-Shabelle basin (including upstream rainfall in Ethiopia and Kenya, supplementary Figure 2) shows 1997 rainfall as well beyond that of the second-wettest season.

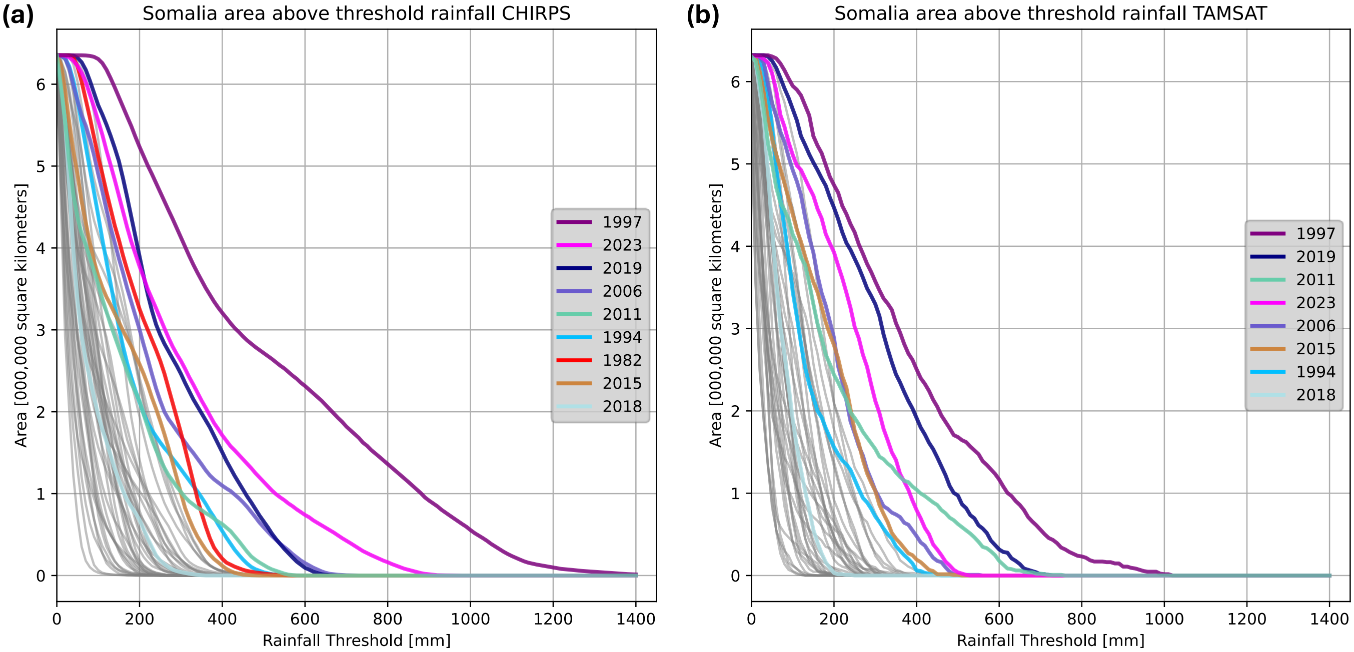


FIGURE 6 Areal rainfall hazard in 1997 was the largest since at least 1981. Showing the total land area of Somalia receiving rainfall above threshold for all OND totals 1981-2023, based on (a) CHIRPS and (b) TAMSAT. Strong El Niño and/or positive IOD years labelled and coloured following Figure 2 whilst others are grey. The legend is ranked according to area receiving at least 400mm, and 2011 is noted for reference as a non-El Niño or positive IOD year which still received one of the highest totals.

2023 rainfall totals were far below those seen in 1997. Yet the actual impact may yet be higher due to more exposed population, given that Somalia's population more than doubled over the intervening 26 years. Estimates of this exposure (Figure 7 for CHIRPS, Supplementary Figure 3 for TAMSAT) indicate that indeed more people lived in areas receiving low to moderate rainfall in 2023: for example, over 10 million people lived in areas receiving at least 200mm of rainfall, compared with fewer than 8 million in 1997. However for all thresholds above 300mm, population exposure is still far greater in 1997. This difference grows with increasing thresholds: at 600mm, 2 million people were exposed in 2023 and over 4 million in 1997. Extreme thresholds see the largest divergence: half a million were exposed to over 1000mm totals in 1997, and none in 2023.

4 | DISCUSSION AND LESSONS LEARNED

In 2023, the largest AA based on a seasonal forecast was possible due to mature operational forecasting, scientific understanding of predictability, flexible funding, lessons from past disasters and collaboration among key stakeholders. Long-term relationships between scientists and humanitarian practitioners built trust, enabling an unprecedented level of preparedness before flooding. But was it responsible for reducing mortality relative to 1997? And what lessons might be learned from this experience? Here we consider these questions.

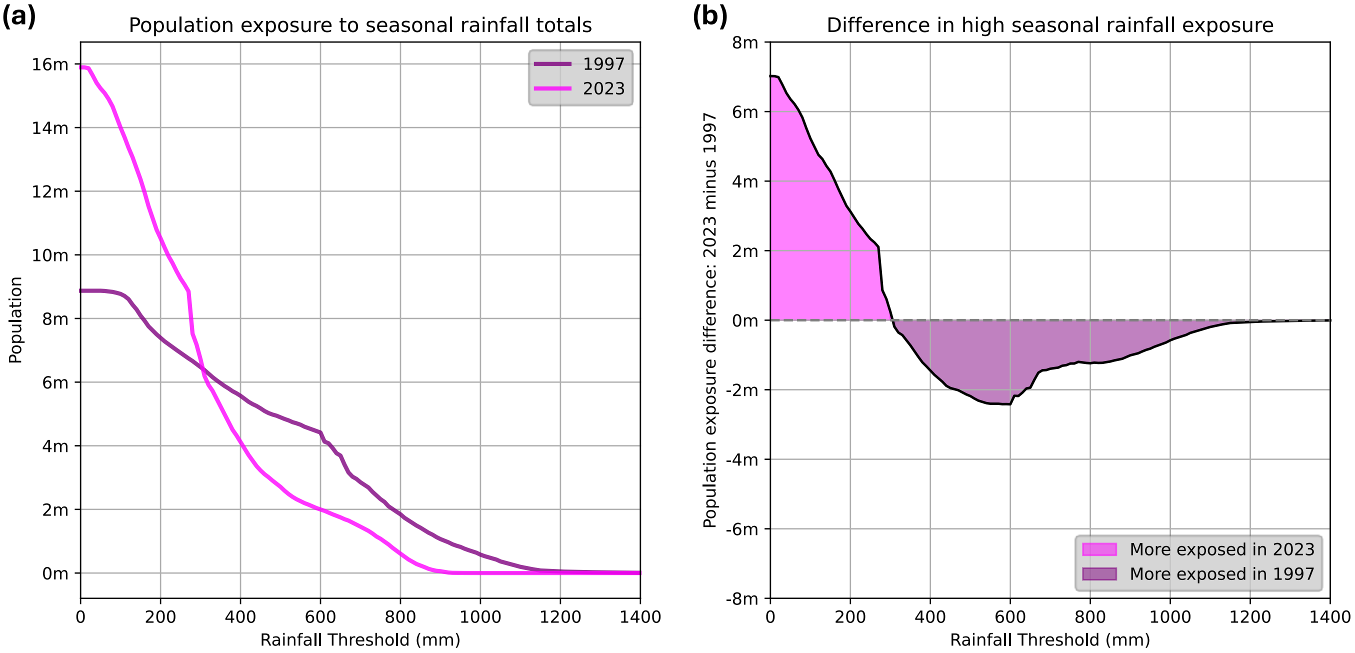


FIGURE 7 Contrasting exposure to high seasonal rainfall. (a) The total population count in Somalia living in a location receiving above a specified threshold of rainfall in 1997 and 2023, based on CHIRPS rainfall. (b) The difference in population exposed between 2023 and 1997. Population data from WorldPop 100m unconstrained counts for Somalia, upscaled to the respective precipitation data resolution.

4.1 | Was AA the primary reason for reduced mortality in 2023?

Forecasting capacity, dissemination, trust, and willingness to act in 2023 were clearly higher than 1997. This was not due to better inherent predictability, as 1997 forecasts clearly warned of an El Niño and likelihood of a very wet season.[#]. Rather it was maturity of the technology and increased capacity, alongside and trust and experience with AA, which transformed the 2023 forecast from ”useful” to ”used” (Lemos et al. 2012). Here we review the quantitative and qualitative evidence for AA improving outcomes, before synthesising a perspective on the higher 1997 mortality, taking into account drivers of vulnerability as well as differences in hazard and exposure documented above.

Quantitative analysis indicates a positive impacts of AA. Post-assistance evaluation from WFP showed AA increased access to early warning information by 15%, and receipt of information by 27% (WFP 2024). This analysis also showed improved food security outcomes with AA, with acceptable consumption rates for groups receiving AA (+14%) compared to a control group, although this increase was yet lower than groups only receiving post-response (+35%). Analysis of cash transfers carried out by Save the Children and others in Beletweyne demonstrated that when some cash was transferred ahead of flooding, households relied less on emergency coping mechanisms, compared to when assistance was provided post-flooding (IMPACT Initiatives 2024). In addition, those receiving all cash after the onset of flooding were also more likely to end the season with debts compared to those receiving money in advance, despite both groups receiving the same total overall. Anticipatory cash also saw improved outcomes in food security and protection (DRC 2024).

[#] Although forecast probabilities in the 1997 IRI forecast were less confident than the ICPAC forecast in 2023 (60% vs 85%), other forecasts in 1997 showed high confidence of a unprecedented wet season (Figure 1b)

Qualitative reported that key advantages of AA were such as greater clarity and planning, financial efficiencies, and ease of post-flood support due to pre-positioned supplies (ICRC 2024). Anecdotal reports confirmed benefits and asserted mortality reduction:

> "The warnings were helpful. While we could not do much about the farms, the warnings from media or Hormud (Mobile Company) made us vigilant about our houses, allowing us to move easily when the floods arrived"
>
> "We received warnings on our mobile phones, we listened and moved. This saved our lives."
>
> - Abdullahi Ahmed Wasuge & Carabo Abdi Tifow (FAO 2024).

The above evidence confirms that AA reduced risk improved outcomes. However, to attribute the driver of 90% reduction in deaths compared to 1997, we consider hazard, exposure and vulnerability holistically.

Considering hazard magnitude: rainfall totals in 1997 were substantially higher than 2023, despite a similar large-scale climate state. A direct comparison of flood hazard resulting from these two rainfall seasons is precluded the lack of river monitoring in 1997, with the FAO-SWALIM monitoring network only established following the event (a comparative analysis of satellite-estimated inundation is flawed by data inconsistencies – see methodology for details). On one hand we cannot necessarily assume that higher rainfall ultimately led to higher river levels and inundation; one might speculate that the sustained dry conditions ahead of 2023 may hardened soil, increasing runoff and leading to flashier flooding. Yet the narrative description of specific incidents from in-season reporting strongly suggests significantly higher inundation in 1997, with many villages washed away (SACB 1997b) and reports of people stranded in trees for weeks (SACB 1997e), with surrounding water reported as 'infested' with hippos (SACB 1997c) and crocodiles (SACB 1997d).

Considering exposure and with rainfall total as an imperfect proxy for flood hazard, many more people were exposed to flooding in 1997 despite a much smaller population. Uncertainties in population data must be acknowledged: our 2023 estimate is based on 2020 WorldPop data, which itself is largely based on extrapolation from census data of previous years. Any significant internal migration following the extended drought period 2020-2023 will not be represented in this data and so population exposure estimates were not precise.[‖] However high rainfall totals seen over large areas in 1997 were not seen anywhere in 2023: the estimate of the population exposued to this level of rainfall in 2023 (i.e. zero) is robust to population uncertainty.

Comparing the differences in vulnerability between the two periods is challenging due to the lack of data and the multifaceted nature of vulnerability. However, key differences may be noted. In 1997 Somalia was emerging from the civil war, with years without functioning government, formal economy or organised national systems to contend with major disasters (Bradbury and Coultan 1998). Conflict and instability meant many areas were inaccessible to humanitarian aid, as noted in contemporary reports. For instance, some months ahead of the season the international community had suspended all relief and development in the Bay region after a gunmen killed an international staff member of MSF (WFP 1997). This lack of institutional capacity and accessibility likely contributed significantly to high vulnerability of populations. Indeed, it was explicitly noted

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[‖] Since population data is integrated to the rainfall spatial grid, the data will be robust to migration of distances smaller than these gridboxes (e.g. 25km for CHIRPS).

"neither the country nor the humanitarian system had the necessary capacities to contend promptly and fully effectively with a natural disaster on the scale of the flood emergency" (Bradbury and Coultan 1998).

By contrast, 2023 occurred in a period of comparative political stability with a national capacity to respond to disasters, as represented by SoDMA. Yet at the same time, multiple seasons of failed rains preceding the 2023 flooding (Odongo et al. 2024), may have been a factor in exacerbating both flood hazard (drier soil increasing runoff) and vulnerability (drought impacts reducing individual and community coping capacity). In particular, individual physical resilience to flood-related water-borne diseases may have been negatively impacted by drought-related malnutrition. However this must in turn must be set against the background of a long-term decline in the cholera case-fatality rate in Somalia, which was around 4% in 1997 and less than 1% by 2023 (WHO 2022).

Bringing together evidence and discussion above, we come to rest on two key reasons to doubt that AA was the primary reason for lower mortality in 2023. Firstly, the substantially higher rainfall in 1997 may sufficiently explain the higher mortality alone. Human and natural systems have a finite capacity to absorb flood impacts and a non-linear relationship between seasonal rainfall and mortality risk is likely - low mortality risk low up to some threshold then increasing significantly beyond it. With this, the millions more people in 1997 exposed to higher rainfall totals is easily sufficient to explain the mortality difference. Secondly, post-civil war Somalia in 1997 was undoubtedly highly vulnerable to the flood hazard with a well-documented lack of national capacity to respond. This, alongside persistent conflict-related accessibility issues and eroded individual and community coping capacity indicates significantly enhanced vulnerability. This was likely a crucial factor in driving higher impact in 1997.[**]

In conclusion, while quantitative, qualitative, and anecdotal evidence shows that well-designed AA helped reduce some flood impacts in 2023, it is unlikely they were the primary reason for lower mortality compared to 1997. The 1997 death toll likely resulted from a combination of much higher rainfall totals and higher vulnerability linked to the recent civil war.

4.2 | Forecasting and anticipation: lessons learned

With climate change, we expect more frequent extreme pIOD events (Cai et al. 2014), which are likely to drive rainfall in Somalia exceeding that seen in 1997 (MacLeod et al. 2024). Resilience to such an event should be a priority. In order to support this, institutions have continued to internally and collaboratively reflect and learn from the experience of 2023.[††] Arising from reflections, we propose three recommendations to ensure Somalia's flood AA is as ready as possible for a 1997-scale event.

1. **National capacity for localised forecasts, including nowcasting.** Beyond the donor-supported FAO-SWALIM, no nationally owned organisation provides localised forecasting in Somalia. In 2023 institutions pragmatically relied on regional centres, primarily ICPAC, alongside global models rather than national institutions. SoDMA currently leads the National Multi-hazard Early Warning Center (NMHEWC), coordinating

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[**] 2023 may also be compared with 2019, which also saw pIOD, 2023-level rainfall, and more response capacity (e.g. existence of SoDMA, FAO-SWALIM monitoring). Without El Niño, forecasts of wet season came later, with less confidence (50–60%, Wainwright et al. (2021)) and no coordinated AA occurred at the scale of 2023. If all else were equal and AA responsible for driven the large reduction in mortality we would expect far more deaths in 2019, but only 17 were recorded. However all else isn't equal: the higher 2023 deaths may reflect a larger impact of higher vulnerability following the long-term drought, for instance.

[††] This reflection including an online workshop in January 2024, "Learning from experience: strengthening flood anticipation in Somalia." from which the concept for this manuscript originated.

institutions and responses for disaster management and a recent roadmap (Islam 2024) proposes establishing a National Meteorological and Hydrological Service (NMHS) within NMHEWC. Such a centre could become the single official source of early warning across hazards, integrating all monitoring and forecasting data, incorporating local and traditional knowledge, and communicating alerts effectively through multiple channels and timescales. This should include monitoring of nowcasting for imminent extreme rainfall - critical for flash flooding and already estimated from satellite data and available in real-time (through the FASTA app for instance https://fastaweather.com/web/ca/) - but this should be mainstreamed with automated monitoring and alerting capacity, with nationally-owned capacity to integrate into existing dissemination capabilities such as Digniin (FAO-SWALIM 2015), which itself should be vastly enhanced in coverage.

Building national capacity and enhancing dissemination of these critical warnings will provide communities, national agencies, and international partners with clear and timely information, creating a shared situational understanding. Regardless of its eventual institutional placement, a robust, reliable national NMHS is critical for minimising future flood risk. International support should work in tandem with government to support this. Indeed, AA can act as a catalyst for NMHS development: engagement with NMHS as they build capacity makes forecast needs visible, motivating institutional and political investment while fostering collaborations with future users. In the short term, international agencies may still rely on global and regional products, but early engagement allows humanitarian actors to contribute to co-design, ensuring forecasting products are relevant and actionable.

2. **Strong links between climate centres, humanitarians and government.** In 2023 agencies adopted contrasting monitoring strategies, from the flexible approaches of ICRC and IRC to formal protocols by SRCS and WFP, with strong co-design with SoDMA. No single approach appears to achieve inherently superior outcomes, though reflections identified pre-agreed anticipatory triggers enables timely and effective response.

   As AA develops, diverse approaches help find optimal approaches. But as the approach matures and becomes institutionalised, working toward a harmonised approach to triggers - centered on government, as identified in the recent Somalia National Anticipatory Action Roadmap (Federal Government of Somalia 2026) - ensures broad coverage and consistent messaging. Not least this supports efficient funding as the sector faces financial constraints. Humanitarian organisations in particular would benefit from central and transparent evaluation, interpretation and engagement support from mandated agencies, rather than many repeating similar analysis, processes and activity.

   Between forecasters and humanitarian actors, relationships are critical. Institutional and personal networks, such as between ICRC and the RCRCCC, enabled timely interpretation and bespoke monitoring of evolving forecasts. Boundary organisations such as the RCRCCC who can work to support this interpretation are critical. Building and nurturing a web of overlapping relationships remain vital for shared learning, harmonised approaches, and supporting lower-capacity organisations. In particular, upscaling existing effective actions (cash transfers, early warning) should be a priority as well as determining what other actions may be needed in the face of possibly overwhelming future hazard.

3. **Routine, decision-relevant provision of global forecasts evaluation.** Whilst national capacity is being developed, global forecasts remain critical for AA in regions with limited national capacity and particularly when conflict is a factor (Jaime et al. 2022). Leading up to the 2023 Somalia flooding humanitarian agencies were searching for forecasts to develop triggers but were hampered in places by lack of guidance on what accuracy to expect, limiting ability to interpret and link to actions.

To increase the usability of forecasts, global forecast providers might systematically provide skill assessments for action-relevant metrics beyond ”headline” skill scores. Routine provision of this evaluation with every new model version would reduce the need for ad hoc assessments, increase confidence, and enable wider use of forecasts. This assessment and communication should be co-designed with non-technical users, a critical step to increase usability (Lemos et al. 2012). The WMO already leads by setting standards and fostering collaboration on verification, with a long movement toward opening up of real-time forecast data. The same mindset should be taken forward into forecast evaluation: setting an expectation that all forecasts should come with a skill assessment for that specific model version by default, in a form that non-specialist users can easily understand.

Additionally, global and regional forecast producers might explore communicating shifts in probabilities for extreme seasonal events well beyond standard terciles — for example, 1-in-100-year rainfall seasons. This would requires careful evaluation of reliability of information, but providing information on worst-case scenarios alongside “wetter than normal” forecasts would be highly actionable for the humanitarian community, particularly given projections of more frequent and unprecedented rainfall extremes (Cai et al. 2014, MacLeod et al. 2024).

In conclusion, we note the impressive AA and response in 2023 helped reduce impacts. However although the 2023 flooding was anticipated as “once in a century” (UN CERF 2023a), it was far exceeded by 1997. If 1997-level rainfall happened again with a 2023-level of preparedness, would mortality have been significantly reduced? We cannot confidently say it will, and consider 2023 as a rehearsal for a 1997-level event, expected to recur more frequently under climate change. AA should prepare for this threat - communicating the best possible warnings to communities on time, whilst empowering and resourcing them to take action to protect themselves.

We end by noting that this challenge may be arriving sooner than anticipated, with spring 2026 seeing a remarkably fast-growing El Niño forecast. Should the IOD respond in turn, this could well be a 1997-level event (or greater, given increased moisture holding capacity of the atmosphere in our warmer climate. Deep collaboration - and funding - of anticipatory preparedness alongside long-term risk reduction is more urgently needed than ever, to give the best hope of meeting the challenge of climate change in Somalia. Now is the time to make it happen.

Author Contributions

All authors contributed to initial discussions of work leading to this manuscript, along with reviewing and editing of the draft. DM co-ordinated the study, carried out data analysis drafted and finalised the manuscript. MSP provided flood inundation data.

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Conflicts of Interest

The authors declare no conflicts of interest.

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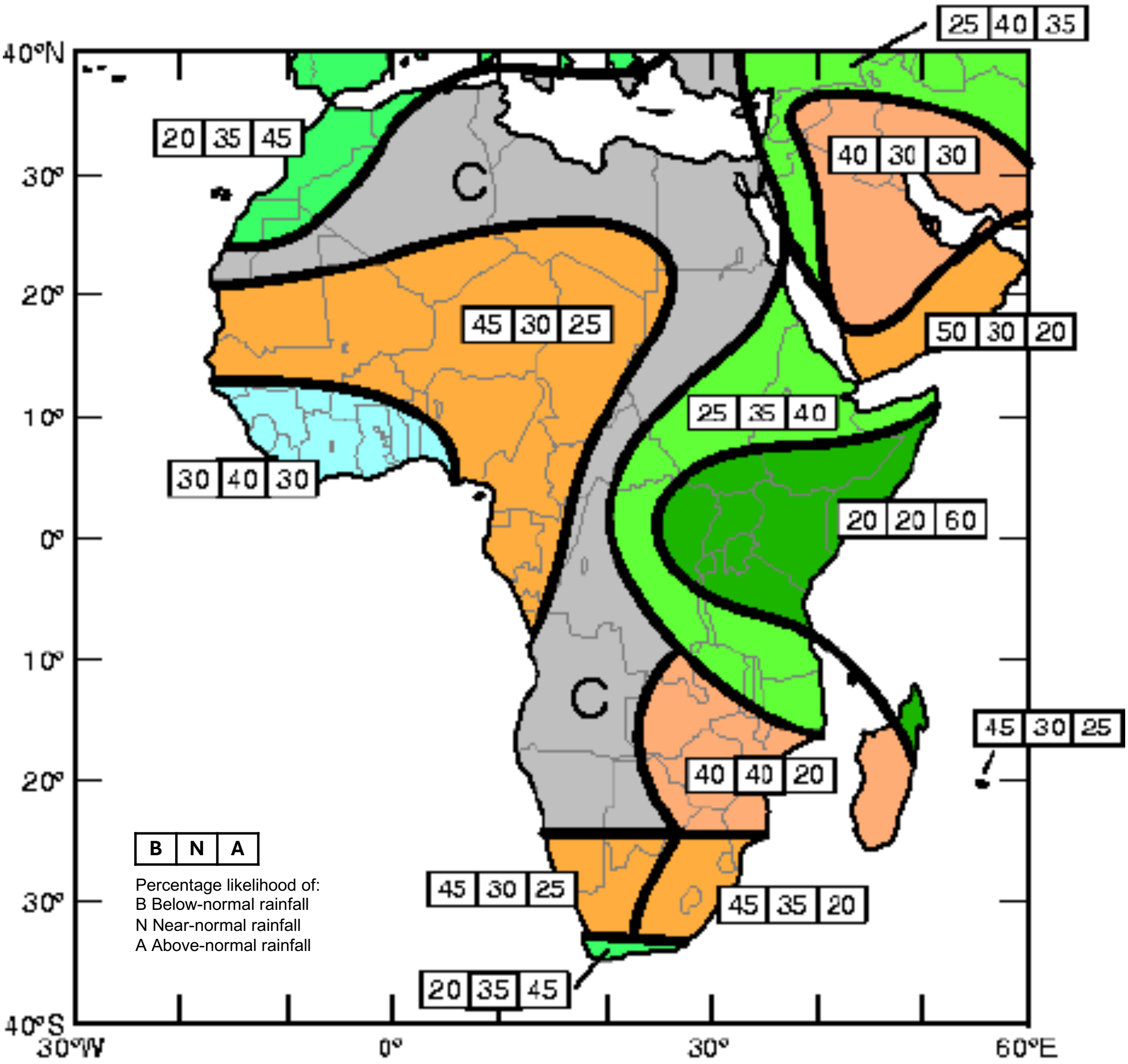
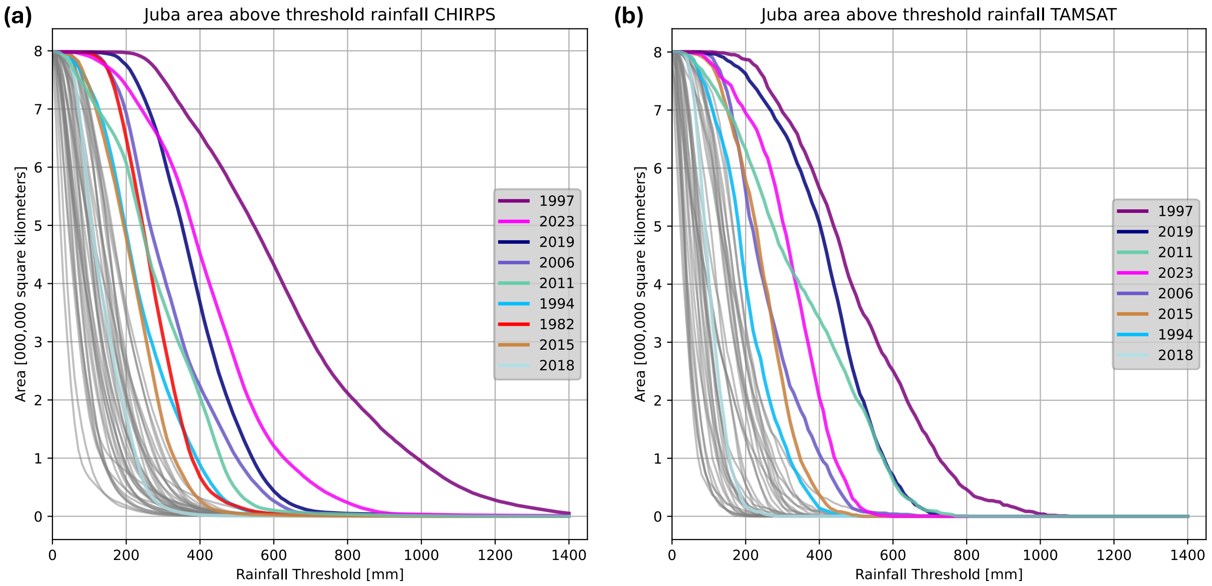
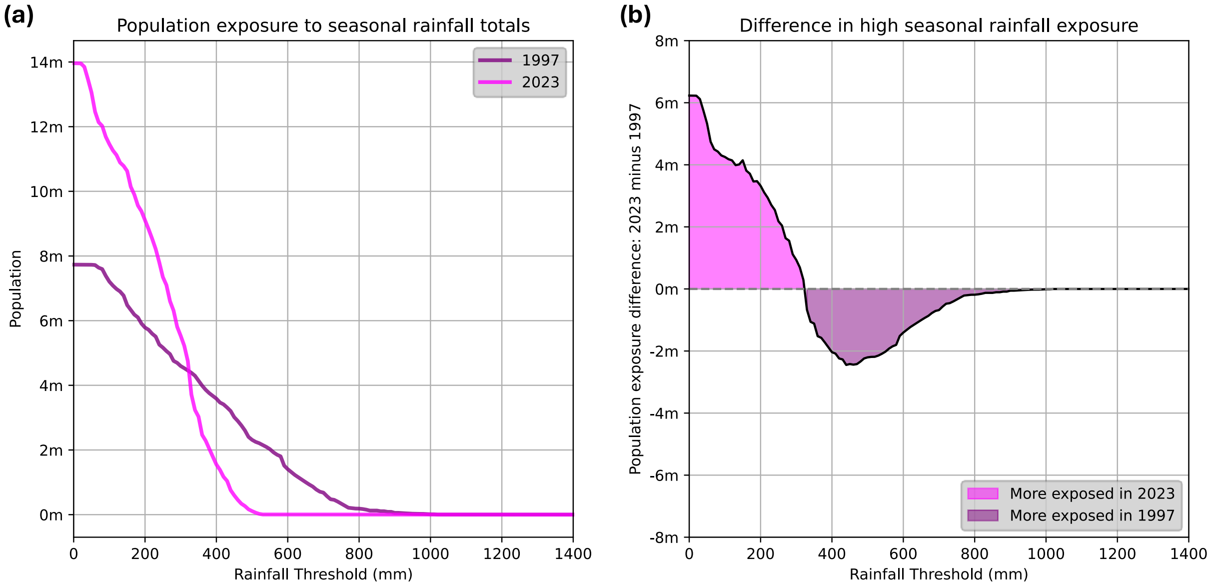


Supplementary Figure 1: The first seasonal forecast issued by the International Research Institute for Climate Prediction (IRI), October 1997. Below/Near/Normal categories are based on tercile divisions of the local historical distribution. The grey area "C" indicates regions without strong signal.



Supplementary Figure 2 Areal rainfall hazard in 1997 was the largest since at least 1981. Showing the total area of the Juba-Shabelle basin receiving rainfall above each threshold for all OND 1981-2023, based on (a) CHIRPS and (b) TAMSAT. Strong El Niño and/or positive IOD years labelled and coloured whilst others are grey. The legend is ranked according to area receiving at least 400mm, and 2011 is noted for reference as a non-El Niño or positive IOD year which still received one of the highest totals.



Supplementary Figure 3 Contrasting exposure to high seasonal rainfall. (a) The total population count in Somalia living in a location receiving above a specified threshold of rainfall in 1997 and 2023, based on TAMSAT rainfall. (b) The difference in population exposed between 2023 and 1997. Population data from WorldPop 100m unconstrained counts for Somalia, upscaled to the respective precipitation data resolution.